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SOLAR/1050-79/03

Monthly Performance Report

BOND CONSTRUCTION

MARCH 1979

U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

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MONTHLY PERFORMANCE REPORT

BOND CONSTRUCTION

MARCH 1979

I. SYSTEM DESCRIPTION

The Bond Construction site is a single-family residence in Gladstone, Missouri. The home has approximately 1400 square feet of conditioned space. Solar energy is used for space heating the home and preheating domestic hot water (DHW). The solar energy system has an array of flat-plate collectors with a gross area of 465 square feet. The array faces south at an angle of 37 degrees to the horizontal. A propylene glycol solution is the transfer medium that delivers solar energy from the collector array to an external heat exchanger. Water is the transfer medium that delivers solar energy from the external heat exchanger to storage and from storage to the hot water load and liquid-to-air heat exchanger in the furnace. Air is the transfer medium that delivers solar energy to the space heating load. Solar energy is stored in the basement in an 800-gallon steel storage tank with walls approximately 1/4-inch thick. The storage tank has 4-inch polyurethane insulation on the bottom and 8-inch fiberglass insulation on the top and sides. Preheated city water is stored in an 82-gallon DHW tank. When solar energy is insufficient to satisfy the space heating load, a gas furnace provides auxiliary energy for space heating. Similarly, an electrical immersion heater in the DHW tank provides auxiliary energy for heating the supply water. Solar energy is transferred from the storage tank to the hot-air heating system by a liquid-to-air heat exchanger contained in the furnace ductwork; solar energy is transferred from the storage tank to the DHW tank by an annular heat exchanger jacket around the hot water tank. The house also contains a fireplace with an integral fan; the fireplace is only instrumented for monitoring fan power consumption. The system, shown schematically in Figure 1, has 5 modes of solar operation.

Mode 1 - Collector-to-Storage: This mode activates when there is a temperature difference of 20°F between a control sensor located at the collector and a control sensor located inside the storage tank (near the bottom). At this time the controller turns on both the collector and storage circuit pumps (P1 and P2, respectively). Solar energy is transferred from the collector to the storage tank by an external heat exchanger. Both pumps continue to operate until the temperature difference is less than 5°F; the controller then turns both pumps off.

Mode 2 - Storage-to-Space Heating: This mode activates when the room temperature drops to the setting on the house thermostat. At this point, this mode is initiated if the storage temperature, measured by a control sensor inside the tank (near the top), is higher than 95°F. If so, the furnace circuit pump (P3) turns on and hot water circulates from the storage tank through a liquid-to-air heat exchanger in the furnace. At the same time the furnace fan turns on, forcing air past the heat exchanger, thereby transferring the solar energy to the heating load. If the room temperature drops an additional increment (set point), the auxiliary gas burner turns on to provide auxiliary energy to the heating load. If storage temperature falls to 90°F

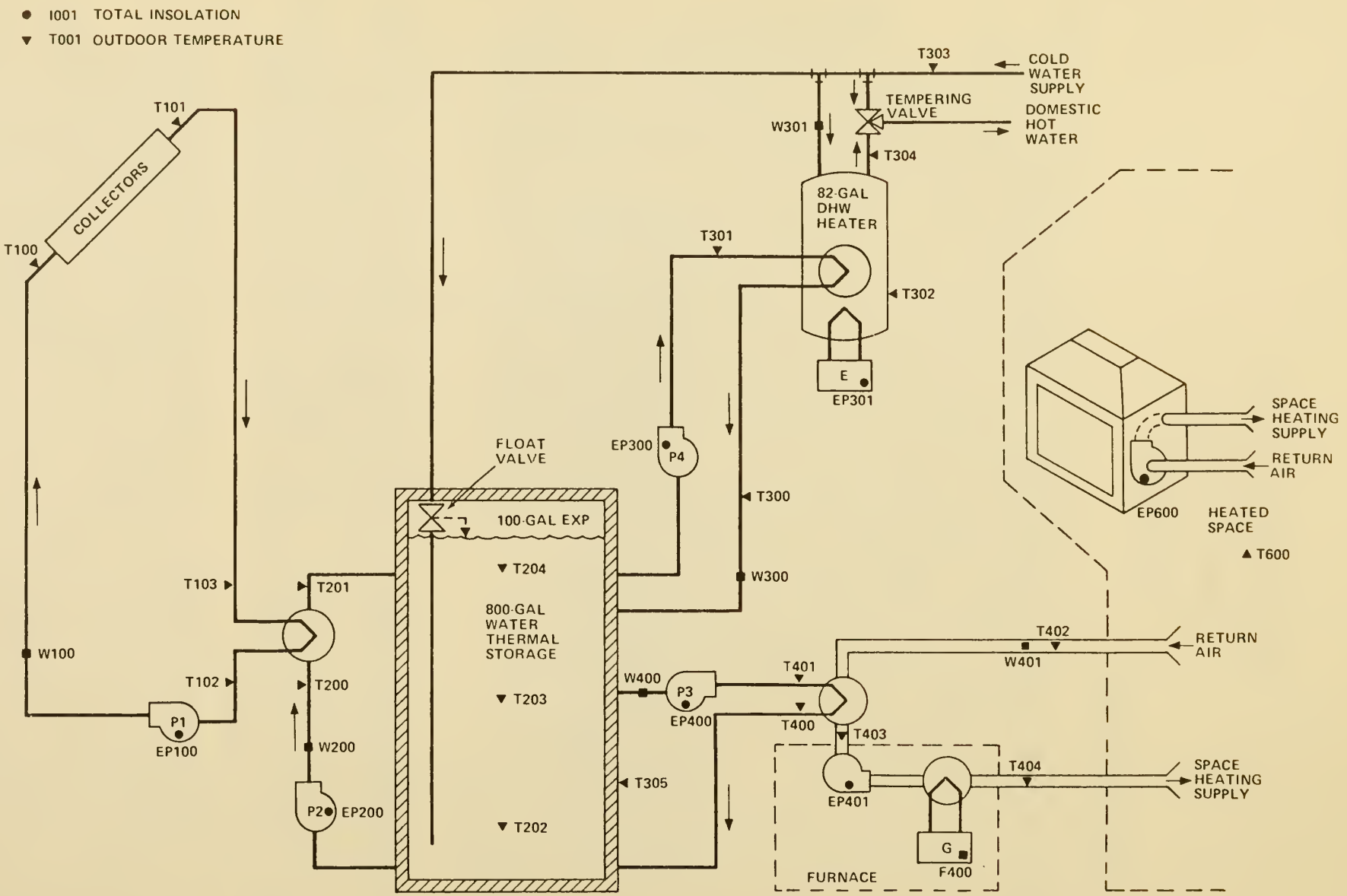

Figure 1. BOND CONSTRUCTION CO. SOLAR ENERGY SYSTEM SCHEMATIC

while in this mode, the mode terminates. However, the fan and gas furnace continue to supply energy until the thermostat demand is satisfied. If the storage temperature is below 95°F when the room thermostat calls for heat, this mode does not activate; auxiliary energy is then provided by the gas furnace. The pump, fan and burner (if on) are turned off when the room temperature exceeds the thermostat setting.

Mode 3 - Storage-to-DHW: This mode activates when there is a temperature difference of 10°F between the control sensor located inside the storage tank (near the top) and the control sensor located in the hot water tank (near the middle). This mode terminates when the temperature difference drops to 3°F. When this mode activates, pump P4 circulates hot water from the storage tank through an annular jacket surrounding the hot water tank; energy is thereby transferred to the water in the hot water tank. The electric immersion heater in the hot water tank turns on to provide auxiliary energy to the DHW if the temperature in the hot water tank drops below its thermostat setting.

Mode 4 - Elimination of Excess Heat in Summer: This mode activates when the storage tank temperature, as determined by an aquastat located in the tank, exceeds 180°F. At this time the collector and storage circuit pumps (P1 and P2, respectively) are activated, thereby transferring energy from the storage tank to the collector by way of the external heat exchanger. This energy is then radiated from the collector to the atmosphere. This mode continues until the storage temperature drops below 180°F.

Mode 5 - Snow Removal in Winter: This mode activates when the collector and storage circuit pumps (P1 and P2) are manually switched on in order to melt the snow that has accumulated on the collector.

II. PERFORMANCE EVALUATION

INTRODUCTION

The site was unoccupied in March and the solar energy system operated continuously during the month. Solar energy satisfied 41 percent of the space heating requirements. The solar energy system provided fossil fuel energy savings of 3.6 million Btu and incurred an electrical energy expense of 0.099 million Btu. A control problem caused intermittent cycling of mode 1 during periods of good insolation. This resulted in mode 1 operation for about 60 percent of the time that potential mode 1 conditions existed during the month. There was no hot water load during March since the water was turned off.

WEATHER CONDITIONS

During the month, total incident solar energy on the collector array was 17.3 million Btu for a daily average of 1198 Btu per square foot. This was below the estimated average daily solar radiation for this geographical area during March of 1446 Btu per square foot for a south-facing plane with a tilt of 37 degrees to the horizontal. The average ambient temperature during March was 42°F as compared with the long-term average for March of 41°F. The number of heating degree-days for the month (based on a 65°F reference) was 709, as compared with the long-term average of 753.

THERMAL PERFORMANCE

System - During March the solar energy system performed somewhat poorer than expected. The expected performance was determined from a modified f-chart analysis using measured weather and subsystem loads as inputs. Solar energy collected was 3.8 million Btu versus an estimated 4.7 million Btu. Solar energy used by the system was estimated by assuming that all energy collected would be applied to the load. Actual solar energy used was 2.2 million Btu. System total solar fraction was 41 percent versus an estimated 88 percent. The poorer performance is attributed to the mode 1 cycling during periods of good insolation. This is discussed further in the "Observations" section below.

Collector - The total incident solar radiation on the collector array for the month of March was 17.3 million Btu. During the period the collector loop was operating, the total insolation amounted to 5.2 million Btu. The total collected solar energy for the month of March was 3.8 million Btu, resulting in a collector array efficiency of 22 percent, based on total incident insolation. Solar energy delivered from the collector array to storage was 3.7 million Btu. Energy loss during transfer from the collector array to storage was 0.052 million Btu. This loss represented 1 percent of the energy collected. Operating energy required by the collector loop was 0.078 million Btu.

Storage - Solar energy delivered to storage was 3.7 million Btu. There were 2.2 million Btu delivered from storage to the space heating subsystem. Energy loss from storage was 1.5 million Btu. This loss represented 41 percent of the energy delivered to storage. The storage efficiency was 59 percent: This is calculated as the ratio of the sum of the energy removed from storage and the change in stored energy, to the energy delivered to storage. The average storage temperature for the month was 107°F.

Space Heating Load - The space heating subsystem consumed 2.2 million Btu of solar energy and 5.4 million Btu of auxiliary fossil fuel energy to satisfy a space heating load of 5.3 million Btu. The solar fraction of this load was 41 percent. Losses from the space heating subsystem were 2.2 million Btu. The space heating subsystem consumed a total of 0.29 million Btu of operating energy, resulting in an electrical energy expense of 0.021 million Btu. It also provided a fossil fuel energy savings of 3.6 million Btu.

OBSERVATIONS

The solar energy system cycled in mode 1 during periods of good insolation during the month. As a result, it is estimated that approximately 40 percent of the potential solar energy was not collected because of this cycling. During periods of good insolation, mode 1 operation averaged about 35 minutes with the quiescent periods (between mode 1 operations) averaging about 30 minutes. The grantee plans to relocate the collector control sensor and change the control temperature differentials of the controller in an attempt to eliminate mode 1 cycling.

The operation of W401 (furnace air flow) was restored on March 1. Therefore, the auxiliary thermal energy supplied to the space heating load for the first

10 hours of March was derived from the auxiliary fossil fuel used during this interval. For the remainder of the month, the auxiliary thermal energy was derived in the normal manner, using the mass flow and temperature differences in the space heating subsystem.

Anomalies in two of the three storage temperature sensors required that the storage temperature be based on the single operating sensor. Since this sensor measures the temperature at the top of the tank, the reported average storage temperature (107°F) is probably higher than the true average storage temperature.

ENERGY SAVINGS

The solar energy system provided a total fossil fuel energy savings of 3.6 million Btu and incurred an electrical energy expense of 0.099 million Btu. The space heating subsystem incurred an electrical energy expense of 0.021 million Btu and provided a fossil fuel energy savings of 3.6 million Btu.

III. ACTION STATUS

The grantee will change the temperature differentials of the collector controller and relocate the collector control sensor in April. Boeing must resolve the sensor anomalies on their next site visit which is tentatively scheduled for late April.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: BOND CONSTRUCTION GLADSTONE, MISSOURI SOLAR/1050-79/03
REPORT PERIOD: MARCH,1979

SITE/SYSTEM DESCRIPTION:
BOND CONSTRUCTION IS A SINGLE FAMILY DWELLING. THE SOLAR ENERGY SYSTEM PROVIDES SPACE HEATING AND HOT WATER. THE COLLECTION/HX LOOP USES A PROPYLENE GLYCOL SOLUTION AS AN ENERGY TRANSFER MEDIUM. THE HX/STORAGE LOOP USES WATER FOR ENERGY TRANSFER AND WATER IS THE STORAGE MEDIUM. THE STORAGE TANK PROVIDES SOLAR ENERGY FOR SPACE HEATING AND DHW THROUGH HX LOOPS. A GAS FURNACE PROVIDES AUXILIARY SPACE HEAT AS REQUIRED. AUXILIARY HEAT FOR THE DHW IS SUPPLIED ELECTRICALLY.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	17.288	MILLION BTU
	37146	BTU/SQ.FT.
COLLECTED SOLAR ENERGY	3.763	MILLION BTU
	8086	BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	42	DEGREES F
AVERAGE BUILDING TEMPERATURE	64	DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.13	
ECSS OPERATING ENERGY	0.078	MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	0.370	MILLION BTU
TOTAL ENERGY CONSUMED	9.456	MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	0.000	5.330	N.A.	5.330 MILLION BTU
SOLAR FRACTION	0	41	N.A.	41 PERCENT
SOLAR ENERGY USED	0.000	2.182	N.A.	2.182 MILLION BTU
OPERATING ENERGY	0.000	0.292	N.A.	0.370 MILLION BTU
AUX. THERMAL ENERGY	0.000	3.148	N.A.	3.148 MILLION BTU
AUX. ELECTRIC FUEL	0.000	N.A.	N.A.	0.000 MILLION BTU
AUX. FOSSIL FUEL	N.A.	5.369	N.A.	5.369 MILLION BTU
ELECTRICAL SAVINGS	0.000	-0.021	N.A.	-0.099 MILLION BTU
FOSSIL SAVINGS	N.A.	3.636	N.A.	3.636 MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.807

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: BOND CONSTRUCTION GLADSTONE, MISSOURI
REPORT PERIOD: MARCH,1979

SOLAR/1050-79/03

SITE/SYSTEM DESCRIPTION:
BOND CONSTRUCTION IS A SINGLE FAMILY DWELLING. THE SOLAR ENERGY SYSTEM PROVIDES SPACE HEATING AND HOT WATER. THE COLLECTION/HX LOOP USES A PROPYLENE GLYCOL SOLUTION AS AN ENERGY TRANSFER MEDIUM. THE HX/STORAGE LOOP USES WATER FOR ENERGY TRANSFER AND WATER IS THE STORAGE MEDIUM. THE STORAGE TANK PROVIDES SOLAR ENERGY FOR SPACE HEATING AND DHW THROUGH HX LOOPS. A GAS FURNACE PROVIDES AUXILIARY SPACE HEAT AS REQUIRED. AUXILIARY HEAT FOR THE DHW IS SUPPLIED ELECTRICALLY.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	18.239 GIGA JOULES
	421835 KJ/SQ.M.
COLLECTED SOLAR ENERGY	3.970 GIGA JOULES
	91822 KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	6 DEGREES C
AVERAGE BUILDING TEMPERATURE	18 DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.13
ECSS OPERATING ENERGY	0.083 GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	0.390 GIGA JOULES
TOTAL ENERGY CONSUMED	9.976 GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	0.000	5.623	N.A.	5.623 GIGA JOULES
SOLAR FRACTION	0	41	N.A.	41 PERCENT
SOLAR ENERGY USED	0.000	2.302	N.A.	2.302 GIGA JOULES
OPERATING ENERGY	0.000	0.308	N.A.	0.390 GIGA JOULES
AUX. THERMAL ENG	0.000	3.321	N.A.	3.321 GIGA JOULES
AUX. ELECTRIC FUEL	0.000	N.A.	N.A.	0.000 GIGA JOULES
AUX. FOSSIL FUEL	N.A.	5.664	N.A.	5.664 GIGA JOULES
ELECTRICAL SAVINGS	0.000	-0.022	N.A.	-0.104 GIGA JOULES
FOSSIL SAVINGS	N.A.	3.836	N.A.	3.836 GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.807

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: BOND CONSTRUCTION GLADSTONE, MISSOURI SOLAR/1050-79/03
REPORT PERIOD: MARCH,1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	0.119	33	0.000	N	0.000	N	0.000
2	0.596	42	0.025	O	0.003	O	0.042
3	0.076	37	0.033	T	0.000	T	0.429
4	0.144	29	0.000		0.000		0.000
5	0.650	36	0.039	A	0.003	A	0.060
6	0.851	42	0.031	P	0.006	P	0.036
7	0.217	33	0.140	P	0.000	P	0.646
8	0.415	33	0.059	L	0.002	L	0.143
9	0.482	36	0.000	I	0.001	I	0.000
10	0.941	25	0.169	C	0.003	C	0.179
11	1.089	42	0.027	A	0.009	A	0.025
12	1.067	49	0.130	B	0.006	B	0.122
13	1.030	51	0.056	L	0.003	L	0.054
14	1.100	39	0.258	E	0.004	E	0.235
15	1.000	30	0.296		0.006		0.296
16	0.617	47	0.112		0.004		0.182
17	0.086	50	0.094		0.000		1.098
18	0.126	59	0.000		0.000		0.000
19	0.956	53	0.000		0.009		0.000
20	0.988	47	0.080		0.004		0.081
21	0.508	47	0.000		0.000		0.000
22	0.059	53	0.000		0.000		0.000
23	0.061	37	0.172		0.000		2.833
24	1.013	30	0.121		0.004		0.119
25	1.120	34	0.075		0.008		0.067
26	0.084	34	0.170		0.000		2.021
27	0.661	37	0.028		0.002		0.043
28	0.577	64	0.025		0.003		0.043
29	0.123	66	0.000		0.000		0.000
30	0.327	52	0.000		0.000		0.000
31	0.204	40	0.042		0.000		0.207
SUM	17.288	-	2.182	N.A.	0.078	N.A.	-
AVG	0.558	42	0.070	N.A.	0.003	N.A.	0.126
NBS ID	Q001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: BOND CONSTRUCTION GLADSTONE, MISSOURI SOLAR/1050-79/03
REPORT PERIOD: MARCH,1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	0.119	0.000	0.000	*	0.000
2	0.596	0.151	0.139	48	0.234
3	0.076	0.000	0.000	37	0.000
4	0.144	0.000	0.000	29	0.000
5	0.650	0.153	0.126	*	0.194
6	0.851	0.442	0.220	50	0.259
7	0.217	0.000	0.000	33	0.000
8	0.415	0.122	0.078	36	0.187
9	0.482	0.028	0.021	37	0.043
10	0.941	0.182	0.207	27	0.220
11	1.089	0.621	0.327	55	0.300
12	1.067	0.392	0.240	55	0.225
13	1.030	0.215	0.249	57	0.242
14	1.100	0.281	0.297	51	0.270
15	1.000	0.424	0.273	36	0.273
16	0.617	0.274	0.171	55	0.278
17	0.086	0.000	0.000	50	0.000
18	0.126	0.000	0.000	59	0.000
19	0.956	0.604	0.306	55	0.320
20	0.988	0.297	0.321	52	0.325
21	0.508	0.000	0.000	*	0.000
22	0.059	0.000	0.000	55	0.000
23	0.061	0.000	0.000	36	0.000
24	1.013	0.244	0.190	33	0.187
25	1.120	0.544	0.339	40	0.303
26	0.084	0.000	0.000	34	0.000
27	0.661	0.101	0.093	41	0.140
28	0.577	0.162	0.165	70	0.286
29	0.123	0.000	0.000	66	0.000
30	0.327	0.000	0.000	48	0.000
31	0.204	0.000	0.000	41	0.000
SUM	17.288	5.236	3.763	-	-
AVG	0.558	0.169	0.121	46	0.218
NBSID	Q001		Q100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
STORAGE PERFORMANCE

SITE: BOND CONSTRUCTION GLADSTONE, MISSOURI SOLAR/1050-79/03
REPORT PERIOD: MARCH,1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.000	0.000	-0.021	90	1.000
2	0.149	0.025	0.082	94	0.721
3	0.000	0.033	-0.074	93	1.000
4	0.000	0.000	-0.019	88	1.000
5	0.130	0.039	0.042	91	0.624
6	0.233	0.031	0.171	105	0.867
7	0.000	0.140	-0.190	99	1.000
8	0.077	0.059	0.013	93	0.937
9	0.022	0.000	0.000	91	0.000
10	0.209	0.169	0.005	98	0.830
11	0.347	0.027	0.241	111	0.774
12	0.247	0.130	0.039	128	0.686
13	0.241	0.056	0.075	142	0.541
14	0.246	0.258	-0.075	136	0.747
15	0.250	0.296	-0.144	119	0.608
16	0.173	0.112	-0.020	105	0.532
17	0.000	0.094	-0.136	96	1.000
18	0.000	0.000	-0.014	89	1.000
19	0.321	0.000	0.273	109	0.850
20	0.303	0.080	0.086	135	0.546
21	0.000	0.000	-0.048	140	1.000
22	0.000	0.000	-0.049	133	1.000
23	0.000	0.172	-0.214	118	1.000
24	0.201	0.121	0.041	101	0.808
25	0.331	0.075	0.199	113	0.828
26	0.000	0.170	-0.249	112	1.000
27	0.070	0.028	0.032	96	0.857
28	0.161	0.025	0.061	100	0.536
29	0.000	0.000	-0.029	106	1.000
30	0.000	0.000	-0.022	102	1.000
31	0.000	0.042	-0.060	96	1.000
SUM	3.711	2.182	-0.005	-	-
AVG	0.120	0.070	-0.000	107	0.587
NBS ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
HOT WATER SUBSYSTEM

SITE: BOND CONSTRUCTION GLADSTONE, MISSOURI SOLAR/1050-79/03
REPORT PERIOD: MARCH,1979

DAY OF MON.	HOT WATER LOAD MILLION BTU	SOLAR FR.OF LOAD PER CENT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	SUP. WAT. TEMP DEG F	HOT WAT. TEMP DEG F	HOT WATER USED GAL
1	0.000	0	0.000	0.000	0.000	0.000	N	0.000	N	60	140	0
2	0.000	0	0.000	0.000	0.000	0.000	O	0.000	O	60	140	0
3	0.000	0	0.000	0.000	0.000	0.000	T	0.000	T	60	140	0
4	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
5	0.000	0	0.000	0.000	0.000	0.000	A	0.000	A	60	140	0
6	0.000	0	0.000	0.000	0.000	0.000	P	0.000	P	60	140	0
7	0.000	0	0.000	0.000	0.000	0.000	P	0.000	P	60	140	0
8	0.000	0	0.000	0.000	0.000	0.000	L	0.000	L	60	140	0
9	0.000	0	0.000	0.000	0.000	0.000	I	0.000	I	60	140	0
10	0.000	0	0.000	0.000	0.000	0.000	C	0.000	C	60	140	0
11	0.000	0	0.000	0.000	0.000	0.000	A	0.000	A	60	140	0
12	0.000	0	0.000	0.000	0.000	0.000	B	0.000	B	60	140	0
13	0.000	0	0.000	0.000	0.000	0.000	L	0.000	L	60	140	0
14	0.000	0	0.000	0.000	0.000	0.000	E	0.000	E	60	140	0
15	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
16	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
17	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
18	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
19	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
20	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
21	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
22	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
23	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
24	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
25	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
26	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
27	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
28	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
29	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
30	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
31	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
SUM	0.000	-	0.000	0.000	0.000	0.000	N.A.	0.000	N.A.	-	-	0
AVG	0.000	0	0.000	0.000	0.000	0.000	N.A.	0.000	N.A.	60	140	0
NBS	Q302	N300	Q300	Q303	Q301	Q305	Q306	Q311	Q313	N305	N307	N308

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE HEATING SUBSYSTEM

SITE: BOND CONSTRUCTION GLADSTONE, MISSOURI
REPORT PERIOD: MARCH, 1979

SOLAR/1050-79/03

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR.OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	0.311	0	0.000	0.017	0.311		0.529	0.000	0.000	64	33
2	0.174	15	0.025	0.011	0.149		0.255	-0.000	0.042	65	42
3	0.255	13	0.033	0.014	0.222		0.367	-0.000	0.055	64	37
4	0.442	0	0.000	0.021	0.442		0.694	0.000	0.000	63	29
5	0.254	15	0.039	0.014	0.215		0.335	-0.001	0.065	64	36
6	0.195	16	0.031	0.010	0.165		0.287	-0.000	0.051	65	42
7	0.303	46	0.140	0.019	0.163		0.307	-0.002	0.233	64	33
8	0.288	21	0.059	0.016	0.228		0.369	-0.001	0.099	64	33
9	0.245	0	0.000	0.013	0.245		0.400	0.000	0.000	64	36
10	0.365	46	0.169	0.021	0.197		0.282	-0.002	0.281	64	25
11	0.245	11	0.027	0.012	0.218		0.372	-0.000	0.046	65	42
12	0.130	100	0.130	0.007	0.000		0.022	-0.001	0.217	66	49
13	0.056	99	0.056	0.003	0.001		0.016	-0.000	0.093	67	51
14	0.258	100	0.258	0.010	0.000		0.002	-0.002	0.430	65	39
15	0.296	100	0.296	0.016	0.000		0.014	-0.003	0.493	64	30
16	0.157	71	0.112	0.012	0.045		0.077	-0.002	0.187	65	47
17	0.171	55	0.094	0.012	0.077		0.124	-0.001	0.157	65	50
18	0.015	0	0.000	0.001	0.015		0.047	0.000	0.000	66	59
19	0.010	0	0.000	0.000	0.010		0.026	-0.000	0.000	67	53
20	0.082	97	0.080	0.003	0.003		0.025	-0.001	0.133	66	47
21	0.000	0	0.000	0.000	0.000		0.011	0.000	0.000	63	47
22	0.000	0	0.000	0.000	0.000		0.014	0.000	0.000	61	53
23	0.172	100	0.172	0.010	0.000		0.020	-0.002	0.286	59	37
24	0.314	39	0.121	0.016	0.193		0.261	-0.001	0.202	58	30
25	0.169	44	0.075	0.009	0.094		0.166	-0.001	0.125	59	34
26	0.170	100	0.170	0.011	0.000		0.014	-0.002	0.283	59	34
27	0.132	22	0.028	0.007	0.103		0.201	-0.000	0.047	59	37
28	0.027	91	0.025	0.002	0.002		0.023	-0.000	0.041	64	64
29	0.000	0	0.000	0.000	0.000		0.012	0.000	0.000	70	66
30	0.000	0	0.000	0.000	0.000		0.012	0.000	0.000	67	52
31	0.093	45	0.042	0.005	0.051		0.084	-0.000	0.070	60	40
SUM	5.330	-	2.182	0.292	3.148	N.A.	5.369	-0.021	3.636	-	-
AVG	0.172	41	0.070	0.009	0.102	N.A.	0.173	-0.001	0.117	64	42
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

NOT APPLICABLE

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: BOND CONSTRUCTION GLADSTONE, MISSOURI SOLAR/1050-79/03
REPORT PERIOD: MARCH, 1979

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	257	N	33	*	N	N	N
2	1282	O	42	48	O	O	O
3	164	T	37	37	T	T	T
4	309		29	29			
5	1397	A	36	*	A	A	A
6	1828	P	42	50	P	P	P
7	466	P	33	33	P	P	P
8	891	L	33	36	L	L	L
9	1036	I	36	37	I	I	I
10	2022	C	25	27	C	C	C
11	2340	A	42	55	A	A	A
12	2293	B	49	55	B	B	B
13	2212	L	51	57	L	L	L
14	2364	E	39	51	E	E	E
15	2149		30	36			
16	1326		47	55			
17	184		50	50			
18	271		59	59			
19	2055		53	55			
20	2122		47	52			
21	1091		47	*			
22	128		53	55			
23	130		37	36			
24	2177		30	33			
25	2406		34	40			
26	181		34	34			
27	1420		37	41			
28	1240		64	70			
29	264		66	66			
30	703		52	48			
31	439		40	41			
SUM	37146	N.A.	-	-	-	-	-
AVG	1198	N.A.	42	46	N.A.	N.A.	N.A.
NBS ID	Q001		N113			N115	N114

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